JP9115977A2: METHOD AND APPARATUS FOR EVALUATING SEMICONDUCTOR SUBSTRATE

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Abstract: **Problem to be solved**: To provide a method and an apparatus which can obtain high accuracy and resolution and a profile of FPD density in the direction of etching depth.
Solution. A semiconductor wafer W is held on a vacuum chuck 5 in a chamber 1, and is immersed in etchant L. The semiconductor wafer W is at a specified rotational angle within 360°, and further etched. Thereafter, the semiconductor wafer W is taken out of the etchant L, and is cleaned and dried. Subsequently, the traces 10 of air bubbles formed on the surface of the semiconductor wafer W are observed, and the depth at which crystal defect is present is thereby identified according to the direction of the traces 10 of air bubbles.

Other Abstract Info: DERABS C97-304336 DERC97-304336

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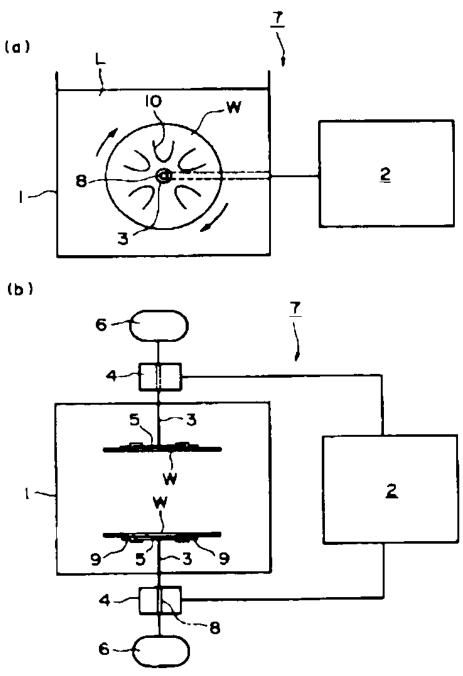
(54)【発明の名称】　半導体基板の評価方法および評価装置

(57)【要約】
【課題】　精度および分解能の高いＦＰＤ密度のエッチング深さ方向プロファイルが得られる方法および装置を提供する。
【解決手段】　容器１内の真空チャック５に半導体ウェーハＷを固定し、これをエッチング液Ｌ中に浸漬させ、半導体ウェーハＷを一定の角速度で３６０°以内で回転させながら、エッチングを行なう。その後、半導体ウェーハＷをエッチング液Ｌから取り出し、洗浄、乾燥後、半導体ウェーハＷの表面に形成された気泡の軌跡１０を観察することにより、気泡の軌跡１０の方向に基づいて結晶欠陥の存在する深さを識別する。



【特許請求の範囲】

【請求項１】　選択エッチング中に半導体基板の表面に気泡の軌跡を形成する結晶欠陥のエッチング深さ方向の密度分布を検出する方法であって、
選択エッチング液中に半導体基板を立てた状態で浸漬させ、該半導体基板の任意の法線方向を回転軸として一定の角速度かつ３６０°以内で該半導体基板を回転させた後、該半導体基板を前記選択エッチング液から取り出し、前記半導体基板の表面に形成された気泡の軌跡を観察することにより、該気泡の軌跡の方向に基づいて結晶欠陥の存在する深さを識別することを特徴とする半導体基板の評価方法。

【請求項２】　請求項１に記載の半導体基板の評価方法において、
前記角速度の値と前記気泡の軌跡の方向からその気泡の軌跡が形成された時点のエッチング時間を求め、使用する半導体基板と選択エッチング液の種類で決まるエッチング速度と前記求めたエッチング時間から前記結晶欠陥の存在する深さを識別することを特徴とする半導体基板における結晶欠陥検出方法。

【請求項３】　選択エッチング中に半導体基板の表面に気泡の軌跡を形成する結晶欠陥のエッチング深さ方向の密度分布を検出するために用いる装置であって、
選択エッチング液を収容し得るとともにその液中に半導体基板を浸漬させ得る容器と、該容器内に設置され前記半導体基板を立てた状態で保持する基板保持手段と、前記半導体基板を前記基板保持手段に保持させた状態で回転させる基板回転手段と、該基板回転手段による半導体基板の回転時の角速度を制御する制御手段、を備えたことを特徴とする半導体基板の評価装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、半導体基板における結晶欠陥、特にフローパターン欠陥のエッチング深さ方向の密度分布を検出するために用いる半導体基板の評価方法および評価装置に関するものである。

【０００２】

【従来の技術】半導体基板における結晶欠陥の検出は、その半導体基板の品質を評価する上で重要な技術となっている。結晶欠陥の一つとして、クロム系化合物と弗酸と水との混合液による選択エッチング、例えばセコエッチング（Secco Etching）のように、エッチング液中にＳｉ結晶を立てた状態で浸液させた際に結晶欠陥から水素等の気体が発生し、その気体が結晶表面に沿って鉛直方向上方に流れる際にエッチングむらが生じ、気泡の軌跡が結晶表面にさざ波模様を形成するようなＳｉ結晶欠陥、いわゆるフローパターン欠陥（Flow Pattern Defect、以下、ＦＰＤと記す）がある。

【０００３】特開平４－１９２３４５号公報に記載の「シリコン単結晶の電気特性検査方法」によれば、ＦＰＤ密度の検出を行なうことによりＳｉ結晶の電気的特性である酸化膜耐圧の評価と同等の評価が可能であるとされている。また、文献（"Recognition of D defects in silicon single crystals by preferential etching and effect on gate oxide integrity" : H.Yamagishi, I.Fusegawa,N.Fujimaki and M.Katayama : Semicond.Sci.Technol.7(1992)A135-A140）によれば、Ｓｉ結晶のエッチング深さ６０μｍでのＦＰＤ密度の検出は、室温のエッチングで行ない、結晶表面（エッチング深さ０μｍ）からエッチング深さ６０μｍまでの範囲の全てのＦＰＤの累積数を検出しており、そのエッチング深さ方向の密度分布までは検出されていない。

【０００４】例えば、ＦＰＤのエッチング深さ方向の密度分布を得るためには次のような操作を行なえばよい。まず、評価したい半導体ウェーハの表面と選択エッチング液面が垂直になるように半導体ウェーハを選択エッチング液中に立てて浸液し、任意時間エッチングを行なう。その後、半導体ウェーハを取り出して乾燥させ、半導体ウェーハ表面の気泡の軌跡１つを１つのＦＰＤが選択エッチングされた結果とみなし、ＦＰＤの計数を顕微鏡観察等の目視により行なう。この際、ＦＰＤが選択エッチング中に発生する気泡の軌跡の方向によってエッチング中の鉛直方向を知ることができる。

【０００５】次に、最初のエッチング時とは異なる任意の方向が鉛直方向となるように半導体ウェーハの方向を変えて浸液させ、前述と同様の操作を繰り返し行なう。エッチング深さはエッチング時間に比例するため、エッチング液に対する試料のエッチング速度が予め分かっていれば、エッチング時間からＦＰＤの出現時のエッチング深さの範囲が分かる。

【０００６】また、ＦＰＤから発生する気体は全てエッチング液中では重力と逆方向に進むため、各回のエッチング時に発生する気泡の軌跡の方向は各回毎に異なり、気泡の軌跡の方向からＦＰＤ出現時間に対応するエッチング深さの範囲が分かる。この方法により、ＦＰＤのような、結晶を浸液した際に結晶欠陥から気体が発生し、その気体によって結晶表面に気泡の軌跡を形成するタイプの結晶欠陥のエッチング深さ方向プロファイルを得ることができる。

【０００７】ところで、上記の方法によりＦＰＤの深さ方向プロファイルを検出する場合、エッチング液から半導体ウェーハを取り出してＦＰＤを計数する際に、完全なクリーン度を持つクリーンルーム内で作業を行なわなければ、半導体ウェーハ表面にゴミが付着し、次回のエッチング後のＦＰＤの計数に支障を来たす。

【０００８】ここで、ＦＰＤ計数に対するゴミの影響を図４を用いて説明する。試料として、室温においてｐ型Ｓｉウェーハ（１００）表面で初期酸素濃度が１４×１０¹⁷atoms/cc(ASTM-121)のＣＺウェーハ（Czochralski法によるウェーハ）とエピ結晶の双方を用い、これら

に水洗のみを行なった後、セコエッチングを５分間行なったサンプルと、水洗後さらにＡＰＭ（アンモニア過水）洗浄を１０分間行ない、その後、セコエッチングを５分間行なったサンプルをそれぞれ作成した。

【０００９】図4は、これら４種のサンプルについて総ＦＰＤ数に対する２００μm以下のフローの大きさを持つＦＰＤの割合を示すグラフである。なお、ＡＰＭ洗浄液としては、NH_4OH：H_2O_2：H_2Oの体積比が１：１：５のものを用いた。そして、横軸には試料と洗浄の種類、縦軸にはＦＰＤ密度の総ＦＰＤ数に対する２００μm以下のフローの大きさを持つＦＰＤの割合をとった。

【００１０】ＡＰＭ洗浄によってウェーハ表面のゴミやパーティクルが除去されることはよく知られており、図４の結果から、ＡＰＭ洗浄を行なうと総ＦＰＤ数に対する２００μm以下のフローの大きさを持つＦＰＤの割合が減少することが分かった。すなわち、図４の結果より、２００μm以下のフローの大きさを持つＦＰＤの発生にはウェーハ表面へのゴミ付着による影響が大きく、正確なＦＰＤの計数はできないと考えられる。つまり、今まで正確なＦＰＤのエッチング深さ方向プロファイルが測定されていないのは、ゴミやパーティクルのＦＰＤ検出への影響が大きいためである。

【００１１】したがって、ゴミやパーティクルによるエッチング時のＦＰＤ検出への影響を排除するためには、前述の従来の方法を用いる限り、エッチングを繰り返す度に洗浄を施さなければならなかった。また、エッチング深さ方向プロファイルの分解能を向上させるためには、時間を細かく区切ってエッチングを行なう必要があった。

【００１２】

【発明が解決しようとする課題】以上に説明したように、従来の結晶欠陥検出方法では、エッチング液へ半導体ウェーハを複数回出し入れすることが必要なため、エッチング液からウェーハを取り出した時にゴミやパーティクルがウェーハに付着し、２回目以降のエッチング後の結晶欠陥計測では正確な測定ができなかった。そして、これを避けるためには、エッチングを繰り返す度に洗浄、乾燥を行なわなければならず、極めて手間や時間が掛かる作業となっていた。

【００１３】また、従来の方法では、結晶欠陥が存在する深さはエッチング時間に対応するある範囲としてしか把握することができない。そこで、より細かい分解能でＦＰＤ密度のエッチング深さ方向プロファイルを得るためには、エッチング時間を細かく区切り、エッチングとＦＰＤの計数作業を何度も繰り返す必要がある。ところが、このようにすると、ゴミ等の付着の機会がますます増えるため、好ましい方法ではない。

【００１４】本発明は、上記の課題を解決するためになされたものであって、ゴミ等の影響を低減することでより精度の高いＦＰＤ密度が得られ、かつ分解能の高いＦＰＤ密度のエッチング深さ方向プロファイルを得ることのできる半導体基板の評価方法および評価装置を提供することを目的とする。

【００１５】

【課題を解決するための手段】上記の目的を達成するために、本発明の半導体基板の評価方法は、選択エッチング液中に半導体基板を立てた状態で浸漬させ、半導体基板の任意の法線方向を回転軸として一定の角速度かつ３６０°以内で半導体基板を回転させた後、半導体基板を選択エッチング液から取り出し、半導体基板の表面に形成された気泡の軌跡を観察することにより、気泡の軌跡の方向に基づいて結晶欠陥の存在する深さを識別することを特徴とするものである。

【００１６】また、具体的には、角速度の値と気泡の軌跡の方向からその気泡の軌跡が形成された時点のエッチング時間を求め、使用する半導体基板と選択エッチング液の種類で決まるエッチング速度と前記求めたエッチング時間から結晶欠陥の存在する深さを識別することができる。

【００１７】また、本発明の半導体基板の評価装置は、選択エッチング液を収容し得るとともにその液中に半導体基板を浸漬させ得る容器と、該容器内に設置され前記半導体基板を立てた状態で保持する基板保持手段と、前記半導体基板を前記基板保持手段に保持させた状態で回転させる基板回転手段と、該基板回転手段による半導体基板の回転時の角速度を制御する制御手段、を備えたことを特徴とするものである。

【００１８】本発明は、選択エッチング液中で結晶欠陥から発生する気体の流れにより半導体基板表面に気泡の軌跡を形成する結晶欠陥密度のエッチング深さ方向分布を、半導体基板を回転させながらエッチングすることにより検出しようとするものである。すなわち、半導体基板をエッチング中に一定の角速度で回転させる際に、例えば任意のエッチング目的時間までに３６０°以内で半導体基板が回転するように角速度を設定する。すると、結晶欠陥の出現した深さはエッチング時間にほぼ比例し、また、エッチング時間は半導体基板の回転角と比例する。したがって、半導体基板の回転角から結晶欠陥の出現した深さが判断できる。

【００１９】図3は、結晶欠陥が各エッチング深さで出現し、その時に発生する気体により基板表面に気泡の軌跡が形成された様子を示す図である。半導体基板の回転角は結晶欠陥の出現時の基板表面の気泡の軌跡の方向から分かり、その回転角から結晶欠陥が出現した深さが分かる。すなわち、出現した結晶欠陥の深さＤ（μm）は、

$$D = Rt = R\theta/\omega = R\theta'/\omega \quad \cdots\cdots (1)$$

ここで、

Ｒ：エッチング速度（μm／秒）

ｔ：エッチング時間（秒）

ω：エッチング中の半導体基板の角速度（°／秒）
θ：結晶欠陥出現時の半導体基板の回転角度（°）
θ' ：基板表面の気泡の軌跡の方向と回転開始時の鉛直方向上方とのなす回転角度（°）
である。

【0020】したがって、基板表面の気泡の軌跡の方向と回転開始時の鉛直方向上方とのなす角度θ_1、θ_2、θ_3毎にその結晶欠陥を顕微鏡観察等により計数すれば、1回のエッチングで結晶欠陥密度のエッチング深さ方向の分布を検出することができ、ゴミの付着はエッチング前に基板表面に存在したもののみとすることができる。また、半導体基板を連続的に回転させて結晶欠陥を検出するため、結晶欠陥密度の深さ方向プロファイルを分解能良く検出することが可能になる。

【0021】

【発明の実施の形態】以下、本発明の一実施の形態を図1および図2を参照して説明する。図1は本実施の形態の結晶欠陥検出装置（評価装置）の構成を示す図であり、図1（a）は装置の側面図、（b）は平面図である。図中符号1は容器、2はコンピュータシステム（制御手段）、3は回転軸（基板回転手段）、4は回転モータ（基板回転手段）、5は真空チャック（基板保持手段）、6は真空チャック用ロータリーポンプ（基板保持手段）、Wは半導体ウェーハ（半導体基板）、Lはエッチング液（選択エッチング液）である。

【0022】本装置7は2枚の半導体ウェーハWを評価できるものであり、容器1の両側面から水平方向に延びる2本の回転軸3、3が設置され、容器1の外部にはこれら回転軸3を回転させるための回転モータ4（本実施の形態ではパルスモータ）がそれぞれ備えられている。そして、回転モータ4には、回転モータ4を駆動させモータ4の回転速度等、回転状態を制御するためのコンピュータシステム2が接続されている。

【0023】各回転軸3の先端には真空チャック5が、他端には真空チャック用ロータリーポンプ6が取り付けられ、回転軸3の内部には真空チャック用チューブ8が挿通されている。したがって、ロータリーポンプ6の作動により半導体ウェーハWが真空チャック5に吸着、固定されるようになっている。

【0024】次に、上記構成の装置7を用いた結晶欠陥検出方法（評価方法）について説明する。手順としては、まず、容器1内にエッチング液Lを入れる前に半導体ウェーハWを真空チャック5に吸着させ、さらに、半導体ウェーハWと真空チャック5の密着を完全にするために、真空チャック5の外周にあたる箇所をテフロンテープ9でシールする。その後、エッチング液Lを容器1に注ぎ入れ、半導体ウェーハWにエッチング液Lが触れた時点をエッチング開始時間とし、それと同時にコンピュータシステム2により回転モータ4を制御しながら半導体ウェーハWを一定の角速度で回転させる。

【0025】なお、この際、ウェーハの角速度を設定する考え方の一例としては、半導体ウェーハWとエッチング液Lの種類でエッチング速度が決まり、適切なエッチング目的時間を決めると、FPDの深さ方向プロファイルを検出する全体の深さが決まる。そして、前記のエッチング目的時間で総回転角度が360°以上となると気泡の軌跡が重なってしまうため、総回転角度が360°以内となるように一定の角速度を設定すればよい。

【0026】その後、半導体ウェーハWをエッチング液Lから取り出し、水洗、乾燥を行なった後、顕微鏡観察等の手段により半導体ウェーハWの表面に形成された各気泡の軌跡10の方向と数を計測する。このようにすれば、気泡の軌跡10の方向から半導体ウェーハWの回転角が分かり、その回転角と角速度からFPDが出現した時点でのエッチング時間が求められる。さらに、そのエッチング時間と予め分かっているエッチング速度に基づいて各FPDの深さを知ることができる。

【0027】

【実施例】ここで、本発明の結晶欠陥検出方法と従来法との比較実験を行なった。以下、その結果について説明する。本実施例の検出方法では、室温でエッチングを行なうこととし、エッチング液としてセコ液、半導体ウェーハとしてp型Siウェーハの（100）表面で初期酸素濃度が14×10^{17} atoms/cc (ASTM-121) のCZウェーハを用いた。また、図1の装置を使用することにより、半導体ウェーハとエッチング液面のなす角度は90°（半導体ウェーハが垂直に立った状態）となる。

【0028】また、前述の（1）式中のパラメータのうち、エッチング速度R＝0．6μm／分として算出し、エッチング中の半導体ウェーハの角速度ω＝0．15°／秒、総エッチング時間30分間と設定した。この条件でエッチングを行なうと、半導体ウェーハが回転する総角度は270°、エッチング深さは延べ18μmに相当することになる。そして、エッチング終了後の半導体ウェーハを水洗、乾燥し、その後、微分干渉顕微鏡を用いて気泡の軌跡を観察し、FPD密度を求めた。

【0029】一方、比較例となる従来の検出方法としては、図1に示す本実施の形態の装置7のうち、容器1、エッチング液L、半導体ウェーハWと、容器1内で半導体ウェーハWを支持する真空チャック5（ロータリーポンプ6）のみを使用し、半導体ウェーハWには実施例で用いたものと同一のCZウェーハを使用した。

【0030】そして、半導体ウェーハを1度エッチング液から取り出し、水洗、乾燥した後、微分干渉顕微鏡観察によりFPD密度を求め、その後、半導体ウェーハ表面の法線方向を軸として半導体ウェーハの方向を90°変えて一定時間エッチングするという操作を繰り返し行なった。エッチングは全部で4回行ない、各エッチング時間は5分間、5分間（累計10分間）、10分間（累計20分間）、10分間（累計30分間）とした。これ

は、エッチング深さに換算すると、３μｍ、６μｍ、１２μｍ、１８μｍに相当する。

【００３１】また、ＦＰＤ密度の表現の仕方としては、1回目のエッチング後に認識した欠陥を０～３μｍ、２回目のエッチング後に認識した欠陥を３～６μｍ、3回目のエッチング後に認識した欠陥を６～１２μｍ、４回目のエッチング後に認識した欠陥を１２～１８μｍの範囲で出現した欠陥、として示すことにした。

【００３２】図２は、上記の実施例の結果と従来例の結果を比較したものである。図２から明らかなように、実施例によるＦＰＤ密度が６μｍ、１２μｍ、１８μｍの各エッチング深さで従来例のＦＰＤ密度に比べてそれぞれ大きく減少している。これは、従来例の場合、総ＦＰＤ数に対する２００μｍ以下のフロー（ＦＰＤからの気泡の軌跡）の大きさを持つＦＰＤの割合が多く、その分をＦＰＤとしてカウントしたためである。

【００３３】ところが、前述した図４の結果から、２００μｍ以下のフローの大きさを持つＦＰＤはウェーハ表面へのゴミ付着による影響が大きいことが実証されている。したがって、本実施例の場合、従来例に比べてＦＰＤ密度が小さいのは、ウェーハ表面のゴミ付着による影響が小さいためと考えられ、精度の高いＦＰＤ密度が得られることが実証された。

【００３４】さらに、従来例の場合、ＦＰＤが、区切ったエッチング時間に対応するエッチング深さの範囲内で発生した、としてしか把握できないため、ＦＰＤの深さ方向密度プロファイルが図２に示すように階段状プロファイルとなってしまう。そこで、エッチング時間をより細かく区切ればプロファイルも細かくはなるものの、エッチングの間にゴミが付着する機会も増えるため、ＦＰＤ密度はますます精度の悪いものとなってしまう。それに対して、本実施例の場合、ＦＰＤの深さ方向密度プロファイルが滑らかな曲線状となり、従来例に比べてＦＰＤの発生状況をより実際に近い状態で把握することができた。

【００３５】なお、本発明の技術範囲は上記実施の形態および実施例に限定されるものではなく、本発明の趣旨を逸脱しない範囲において種々の変更を加えることが可能である。例えば、本実施の形態の装置において、半導体ウェーハを保持する手段として真空チャックを用いたが、これに代えて、半導体ウェーハを機械的に保持するキャリア等を用いてもよく、その他、装置の具体的な構成については種々の変更を加えることが可能である。また、ＦＰＤの検出方法においても、ウェーハの回転速度、エッチング時間等の条件に関しては適宜設定することができ、また、気泡の軌跡の検出に際しても任意の方法を用いてよい。

【００３６】

【発明の効果】以上、詳細に説明したように、本発明の半導体基板の評価方法によれば、半導体基板を一定の角速度で３６０°以内で回転させながらエッチングすることにより、基板表面の各気泡の軌跡の方向からエッチング時間、すなわちエッチング深さが求められ、エッチングを１回行なうのみで結晶欠陥密度のエッチング深さ方向の分布が検出できるため、エッチング時間を区切り、エッチング毎に基板の洗浄、乾燥を行なう必要がなく、結晶欠陥の検出作業を簡略化することができる。また、ゴミやパーティクルの基板への付着による欠陥密度計測への影響が低減することで、従来法に比べて精度の高い結晶欠陥密度を得ることができる。また、半導体基板を連続的に回転させて結晶欠陥を検出するため、欠陥密度の深さ方向プロファイルを分解能良く検出することができる。

【００３７】また、本発明の半導体基板の評価装置を使用することにより、上記のような優れた利点を持つ結晶欠陥の検出方法を容易に実現することができる。

【図面の簡単な説明】

【図１】本発明の一実施の形態である結晶欠陥検出装置を示す概略構成図である。

【図２】同装置を用いた実施例と従来例による比較実験結果であるＦＰＤ密度のエッチング深さ方向プロファイルを示す図である。

【図３】本発明で対象とする結晶欠陥が出現する様子を示す図である。

【図４】従来の問題点を説明するための図であり、ＡＰＭ洗浄の有無による総ＦＰＤ数に対する２００μｍ以下のフローの大きさを持つＦＰＤの割合をＣＺウェーハ、エピ結晶について示す図である。

【符号の説明】

１　容器

２　コンピュータシステム（制御手段）

３　回転軸（基板回転手段）

４　回転モータ（基板回転手段）

５　真空チャック（基板保持手段）

６　真空チャック用ロータリーポンプ（基板保持手段）

７　結晶欠陥検出装置（評価装置）

８　真空チャック用チューブ

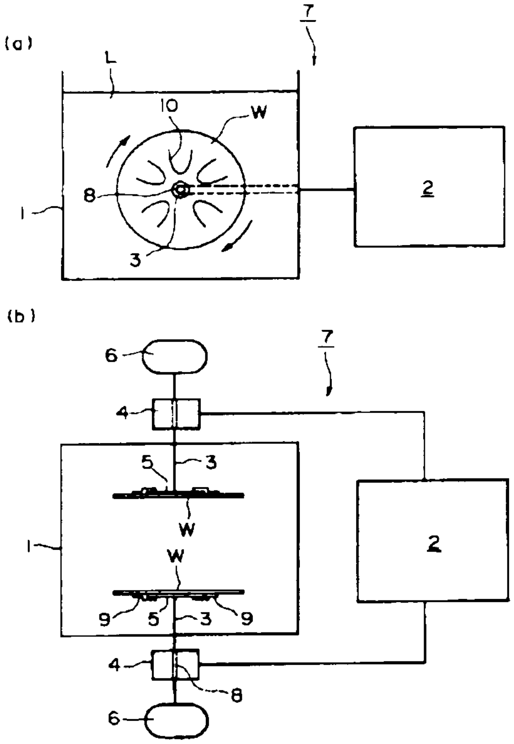
９　テフロンテープ

１０　気泡の軌跡

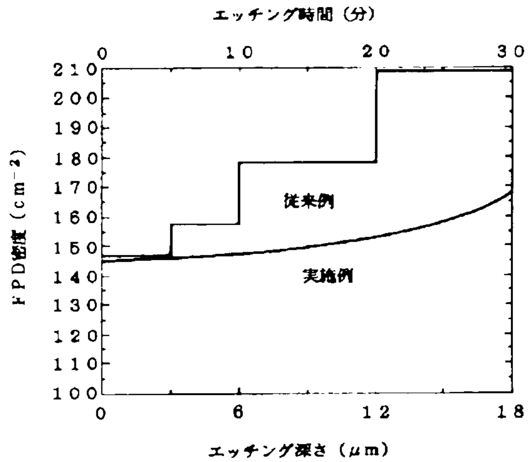
Ｗ　半導体ウェーハ（半導体基板）

Ｌ　エッチング液（選択エッチング液）

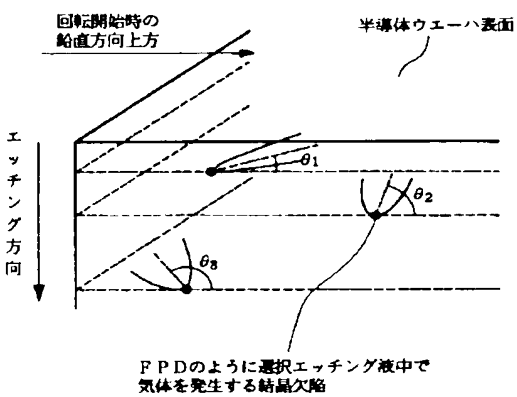
【図1】


(a)
7
L
10
W
8
1
3
2
(b)
6
4
5
3
W
9
8
2

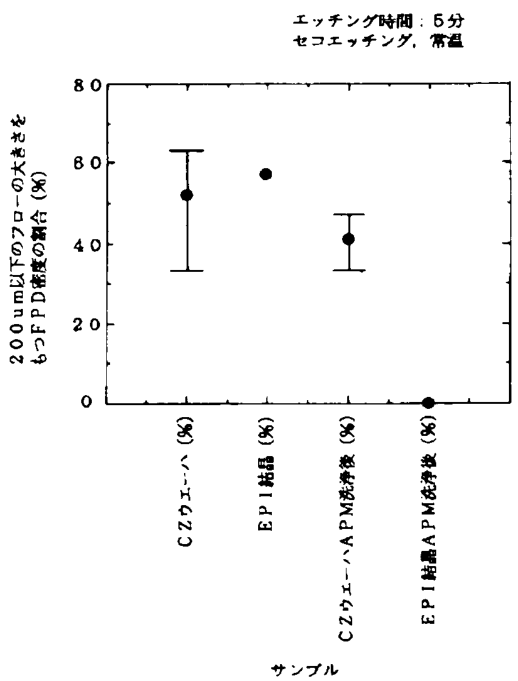
【図2】


エッチング時間（分）
0
10
20
30
210
200
190
180
170
160
150
140
130
120
110
100
FPD密度（cm⁻²）
従来例
実施例
0
6
12
18
エッチング深さ（μm）

【図3】


回転開始時の
鉛直方向上方
半導体ウエーハ表面
エッチング方向
θ_1
θ_2
θ_3
FPDのように選択エッチング液中で
気体を発生する結晶欠陥

【図4】


エッチング時間：5分
セコエッチング，常温
200um以下のフローの大きさを
もつFPD密度の割合（%）
80
60
40
20
0
CZウエーハ（%）
EPI結晶（%）
CZウエーハAPM洗浄後（%）
EPI結晶APM洗浄後（%）
サンプル

Electronic - English Translation of JP 9115977 A2

JAPANESE [JP,09-115977,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

PATENT ABSTRACTS OF JAPAN

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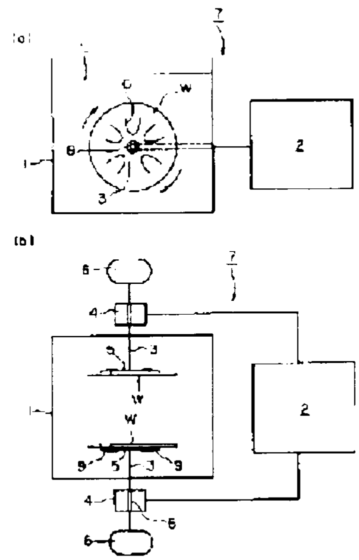
(22)Date of filing : **24.10.1995**

(71)Applicant : **NEC CORP**
(72)Inventor : **NAGATA TAKESHI**

(54) METHOD AND APPARATUS FOR EVALUATING SEMICONDUCTOR SUBSTRATE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a method and an apparatus which can obtain high accuracy and resolution and a profile of FPD density in the direction of etching depth.
SOLUTION: A semiconductor wafer W is held on a vacuum chuck 5 in a chamber 1, and is immersed in etchant L. The semiconductor wafer W is at a specified rotational angle within 360°, and further etched. Thereafter, the semiconductor wafer W is taken out of the etchant L, and is cleaned and dried. Subsequently, the traces 10 of air bubbles formed on the surface of the semiconductor wafer W are observed, and the depth at which crystal defect is present is thereby identified according to the direction of the traces 10 of air bubbles.



LEGAL STATUS

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[Date of final disposal for application]	
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[Date of extinction of right]	21.11.2001

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CLAIMS

[Claim(s)]
[Claim 1] The etching method of the semiconductor wafer to which it is made to move linearly within a perpendicular flat surface to the axis of rotation in the etching method of the semiconductor wafer which is made to rotate the semiconductor wafer dipped into the etching reagent, and **********s simultaneously, rotating this semiconductor wafer.
[Claim 2] The etching system of the semiconductor wafer equipped with the etching-reagent tub into which the etching reagent was poured, a rotation means to rotate a semiconductor wafer in this etching-reagent tub, and the rocking means to which the rotating semiconductor wafer is moved within a flat surface perpendicular to the axis of rotation.
[Claim 3] The etching system of a semiconductor wafer according to claim 2 which has the rack which holds a semiconductor wafer to an abbreviation vertical in the etching-reagent tub into which the etching reagent was poured, and this etching-reagent tub, the driving shaft which rotates a semiconductor wafer in slide contact with the rim of the held semiconductor wafer, and the cam member to which a semiconductor wafer is moved in contact with the rim of this rotating semiconductor wafer.
[Claim 4] while fixing to a driving shaft the piece of maintenance which separates the above-mentioned silicon wafers in the rack which holds two or more silicon wafers and is dipped into an etching reagent by making the rim of a silicon wafer contact two or more driving shafts -- this piece of maintenance -- the surroundings of a driving shaft -- meeting -- a protrusion -- the rack for etching formed by the pin-like member of bottom plurality

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the evaluation method of a semiconductor substrate and evaluation equipment which are used in order to detect the density distribution of the etching depth direction of the crystal defect in a semiconductor substrate, especially a flow pattern defect.
[0002]
[Description of the Prior Art] Detection of the crystal defect in a semiconductor substrate serves as important technology, when evaluating the quality of the semiconductor substrate. Like the selective etching by the mixed liquor of a chromium system compound, fluoric acid, and water, for example, SEKOETCHINGU, (Secco Etching) as one of the crystal defects Where Si crystal is stood into an etching reagent, when carrying out an immersion liquid, gases, such as hydrogen, occur from a crystal defect. In case the gas flows above the perpendicular direction along a crystal front face, etching unevenness arises, and there are Si crystal defect by which tracing of a foam forms a ripple pattern in a crystal front face, and the so-called flow pattern defect (it is described as FPD Flow Pattern Defect and the following).
[0003] According to the "electrical property inspection method of a silicon single crystal" given in JP,4-192345,A, evaluation equivalent to evaluation of the oxide-film pressure-proofing which is the electrical property of Si crystal is enabled by detecting FPD density. moreover Reference () ["Recognition of D] defects in silicon single crystals by preferential etching and effect on gate oxide integrity" : H.Yamagishi, I.Fusegawa, N.Fujimaki and M.Katayama : According to Semicond.Sci.Technol.7(1992) A135-A140 Detection of FPD density with an etching depth [of Si crystal] of 60 micrometers It carried out by etching of a room temperature, the numbers of accumulation of FPD of the range from a crystal front face (an etching depth of 0 micrometer) to an etching depth of 60 micrometers are detected [no], and the density distribution of the etching depth direction is detected.
[0004] For example, what is necessary is just to perform the following operations, in order to obtain the density distribution of the etching depth direction of FPD. First, the immersion liquid of the semiconductor wafer is stood and carried out into selective-etching liquid so that the front face and selective-etching oil level of a semiconductor wafer to evaluate may become perpendicular, and arbitrary time etching is performed. Then, take out a semiconductor wafer, and it is made to dry, and considers that one tracing of the foam of a semiconductor wafer front face is the result to which selective etching of the one FPD was carried out, and viewing of microscope observation etc. performs counting of FPD. Under the present circumstances, FPD can know the perpendicular direction under etching by the direction of tracing of the foam generated in selective etching.
[0005] Next, the immersion liquid of the direction of a semiconductor wafer is changed and carried out so that different arbitrary directions from the time of the first etching may turn into the perpendicular direction, and the same operation as the above-mentioned is repeated, and is performed. Since the etching depth is proportional to etching time, if the etch rate of a sample to an etching reagent understands it beforehand, the range of the etching depth at the time of the appearance of FPD understands it from etching time.
[0006] Moreover, in order that all the gases generated from FPD may progress to gravity and an opposite direction in an etching reagent, the directions of tracing of the foam generated at the time of etching of each time differ for every time, and the range of the etching depth corresponding to FPD appearance time understands them from the direction of tracing of a foam. By this method, when the immersion liquid of a crystal like FPD is carried out, a gas occurs from a crystal defect, and the etching depth direction profile of the crystal defect of the type which forms tracing of a foam in a crystal front face with the gas can be obtained.
[0007] By the way, if it does not work in a clean room with a perfect air cleanliness class in case a semiconductor wafer is taken out from an etching reagent and counting of the FPD is carried out, when detecting the depth direction profile of FPD by the above-mentioned method, dust adheres to a semiconductor wafer front face, and trouble is caused to counting of FPD after next etching.
[0008] here -- FPD -- the influence of dust to counting is explained using drawing 4 As a sample, it sets to a room temperature and an initial oxygen density is 14x1017 atoms/cc (ASTM-121) in a p type Si wafer (100) front face. After only rinsing to these using CZ wafer (wafer by the Czochralski method), and the both sides of an EPI crystal. The sample which performed SEKOETCHINGU for 5 minutes after that was created, respectively by performing APM (ammonia filtered water) washing for 10 minutes further after rinsing with the sample which performed SEKOETCHINGU for 5 minutes.
[0009] Drawing 4 is a graph which shows the rate of FPD which has the size of the flow 200 micrometers or less over the total FPD number about these four sorts of samples. In addition, as an APM penetrant remover, it is NH4OH : H2O2 : H2O A volume

ratio 1 : 1 : 5 The thing was used. And along the horizontal axis, the kind of a sample and washing and the rate of FPD which has the size of the flow 200 micrometers or less over the total FPD number of FPD densities in a vertical axis were taken.

[0010] It was well known by APM washing that dust and the particle on the front face of a wafer will be removed, and the result of drawing 4 showed that the rate with the size of the flow 200 micrometers or less over the total FPD number of FPD decreased, when APM washing was performed. That is, it is thought that the influence by dust adhesion on a wafer front face is larger than the result of drawing 4 to generating of FPD with the size of a flow 200 micrometers or less, and exact counting of FPD is not made. That is, the etching depth direction profile of FPD exact until now is not measured because the influence of the FPD detection on dust or particle is large.

[0011] Therefore, whenever it repeated etching as long as the above-mentioned conventional method was used in order to eliminate the influence of the FPD detection on [at the time of etching by dust or particle], it had to wash. Moreover, in order to raise the resolution of the etching depth direction profile, it needed to etch by dividing time finely.

[0012]

[Problem(s) to be Solved by the Invention] As explained above, in the conventional crystal-defect method of detection, when carrying out the multiple-times receipts and payments of the semiconductor wafer to an etching reagent took out a wafer from eye a required hatchet and an etching reagent, dust and particle adhered to the wafer, and exact measurement was not completed by crystal-defect measurement after etching of the 2nd henceforth. And in order to avoid this, whenever it repeated etching, washing and dryness had to be performed, and it had become the work which requires time and effort and time extremely.

[0013] Moreover, by the conventional method, the depth in which a crystal defect exists can be grasped only as a certain range corresponding to etching time. then -- in order to obtain the etching depth direction profile of FPD density with finer resolution -- etching time -- fine -- dividing -- counting of etching and FPD -- it is necessary to repeat work repeatedly However, if it does in this way, since the opportunity of adhesion, such as dust, will increase increasingly, it is not a desirable method.

[0014] this invention aims at offering the evaluation method of a semiconductor substrate and evaluation equipment which it is made in order to solve the above-mentioned technical problem, and FPD density with a more high precision is obtained by reducing the influence of dust etc., and can obtain the etching depth direction profile of FPD density with high resolution.

[0015]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the evaluation method of the semiconductor substrate of this invention After making it immersed into selective-etching liquid where a semiconductor substrate is stood and rotating a semiconductor substrate for the directions of a normal where a semiconductor substrate is arbitrary within angular velocity and 360 degrees fixed as the axis of rotation, It is characterized by discriminating the depth in which a crystal defect exists based on the direction of tracing of a foam by taking out a semiconductor substrate from selective-etching liquid, and observing tracing of the foam formed in the front face of a semiconductor substrate.

[0016] Moreover, specifically, the etching time at the time of the locus of the air bubbles being formed from the direction of the value of angular velocity and the locus of air bubbles can be found, and the depth in which a crystal defect exists from the etching time which asked the account of before with the etch rate decided by the kind of the semiconductor substrate to be used and selective-etching liquid can be discriminated.

[0017] Moreover, the container which may make a semiconductor substrate immersed into the liquid while the evaluation equipment of the semiconductor substrate of this invention can hold selective-etching liquid, A substrate maintenance means to hold where it was installed in this container and the aforementioned semiconductor substrate is stood, It is characterized by having a substrate rotation means to rotate the aforementioned semiconductor substrate in the state where it was made to hold for the aforementioned substrate maintenance means, and the control means which control the angular velocity at the time of rotation of the semiconductor substrate by this substrate rotation means.

[0018] It is going to detect this invention by **********ing the etching depth direction distribution of the crystal-defect density which forms the locus of air bubbles in a semiconductor substrate front face by the flow of the gas generated from a crystal defect in selective-etching liquid, rotating a semiconductor substrate. That is, angular velocity is set up so that a semiconductor substrate may rotate within 360 degrees by arbitrary etching object time in case it is made to rotate with a fixed angular velocity while etching a semiconductor substrate for example. Then, the depth in which the crystal defect appeared is proportional to etching time mostly, and etching time is proportional to the angle of rotation of a semiconductor substrate. Therefore, the depth in which the crystal defect appeared from the angle of rotation of a semiconductor substrate can be judged.

[0019] Drawing 3 is drawing showing signs that the locus of air bubbles was formed in the substrate front face of the gas which a crystal defect appears in each etching depth, and is then generated. The angle of rotation of a semiconductor substrate is understood from the direction of the locus of the air bubbles on the front face of a substrate at the time of the appearance of a crystal defect, and the depth in which the crystal defect appeared from the angle of rotation understands it. That is, depth D (micrometer) of the crystal defect which appeared is D= Rt = R theta/omega. = Rtheta'/omega .... (1)

It is here and is R:etch rate (micrometer/second).

t: Etching time (second)

omega: Angular velocity of the semiconductor substrate under etching (degree/second)

theta: Angle of rotation of the semiconductor substrate at the time of a crystal-defect appearance (degree)

theta': Angle of rotation of the direction of the locus of the air bubbles on the front face of a substrate, and the perpendicular direction upper part at the time of a rotation start to make (degree)

It comes out.

[0020] the angle theta 1 of the direction of tracing of the foam on the front face of a substrate, and the perpendicular direction upper part at the time of a rotation start to make, theta 2, and theta 3 every -- when carrying out counting of the crystal defect by microscope observation etc., the distribution of the etching depth direction of crystal-defect density should be detected by one etching, and adhesion of dust should only exist in the substrate front face before etching [therefore,] Moreover, in order to rotate a semiconductor substrate continuously and to detect a crystal defect, it becomes possible to detect the depth direction profile of crystal-defect density with sufficient resolution.

[0021]

[Embodiments of the Invention] Hereafter, the gestalt of 1 operation of this invention is explained with reference to drawing 1 and drawing 2. Drawing 1 is drawing showing the composition of the crystal-defect detection equipment (evaluation equipment) of the gestalt of this operation. drawing 1 (a) is the side elevation of equipment, and (b) is a plan. the sign 1 in drawing -- a container and 2 -- for a rotary motor (substrate rotation means) and 5, a vacuum chuck (substrate maintenance means) and 6 are [a computer system (control means) and 3 / the axis of rotation (substrate rotation means) and 4 / a semiconductor wafer (semiconductor substrate) and L of the rotary pump for vacuum chucks (substrate maintenance means) and W] etching reagents (selective-etching liquid)

[0022] This equipment 7 can evaluate two semiconductor wafers W, the two axes of rotation 3 and 3 horizontally prolonged from the both-sides side of a container 1 are installed, and the exterior of a container 1 is equipped with the rotary motor 4 (the form of this operation stepping motor) for rotating these axes of rotation 3, respectively. And a rotary motor 4 is made to drive a rotary motor 4, and the computer system 2 for controlling rotation states, such as rotational speed of a motor 4, is connected to it.

[0023] A vacuum chuck 5 is attached at the nose of cam of each axis of rotation 3, the rotary pump 6 for vacuum chucks is attached in the other end, and the tube 8 for vacuum chucks is inserted in the interior of the axis of rotation 3. Therefore, the semiconductor wafer W sticks to a vacuum chuck 5, and is fixed to it by the operation of a rotary pump 6.

[0024] Next, the crystal-defect method of detection (the evaluation method) using the equipment 7 of the above-mentioned composition is explained. As a procedure, first, before putting in etching-reagent L in a container 1, the semiconductor wafer W is made to stick to a vacuum chuck 5, and further, in order to make perfect adhesion of the semiconductor wafer W and a vacuum chuck 5, the seal of the part which hits the periphery of a vacuum chuck 5 is carried out on the Teflon tape 9. Then, a container 1 is filled with etching-reagent L, the time of etching-reagent L touching the semiconductor wafer W is made into etching start time, and the semiconductor wafer W is rotated with a fixed angular velocity, controlling a rotary motor 4 by the computer system 2 simultaneously with it.

[0025] In addition, if an etch rate is decided by the kind of the semiconductor wafer W and etching-reagent L as an example of a view which sets up the angular velocity of a wafer and suitable etching object time is decided in this case, the depth of the whole which detects the depth direction profile of FPD will be decided. And what is necessary is just to set up a fixed angular velocity so that the total angle of rotation may become less than 360 degrees since the locus of air bubbles will lap if the total angle of rotation becomes 360 degrees or more by the aforementioned etching object time.

[0026] Then, after taking out the semiconductor wafer W from etching-reagent L and performing rinsing and dryness, the direction and number of a locus 10 of each air bubbles which were formed in the front face of the semiconductor wafer W of meanses, such as microscope observation, are measured. If it does in this way, the direction of the locus 10 of air bubbles will show the angle of rotation of the semiconductor wafer W, and the etching time in the time of FPD appearing from the angle of rotation and angular velocity will be found. Furthermore, each depth of FPD can be known based on the etch rate beforehand understood to be the etching time.

[0027]

[Example] Here, the comparative experiments of the crystal-defect method of detection of this invention and a conventional method were conducted. Hereafter, the result is explained. In the method of detection of this example, it supposes that it etches at a room temperature, and an initial oxygen density is 14x1017 atoms/cc (ASTM-121) in the front face (100) of a p type Si wafer as SEKO liquid and a semiconductor wafer as an etching reagent. CZ wafer was used. Moreover, the angle which a semiconductor wafer and an etching-reagent side make becomes 90 degrees (state the semiconductor wafer stood perpendicularly) by using the equipment of drawing 1.

[0028] Moreover, it computed as a part for R= 0.6 micrometer/of etch rates among the parameters in the above-mentioned (1) formula, and set up for [angular-velocity / of the semiconductor wafer under etching / of omega= 0.15 degrees/second /, and total etching time] 30 minutes. When it etches on this condition, the total angle which a semiconductor wafer rotates will spread 270 degrees and the etching depth, and will be equivalent to 18 micrometers. And the semiconductor wafer after an etching end was rinsed, it dried, tracing of a foam was observed after that using the differential interference microscope, and it asked for FPD density.

[0029] On the other hand, as the conventional method of detection used as the example of comparison, only the vacuum chuck 5 (rotary pump 6) which supports the semiconductor wafer W among the equipment 7 of the gestalt of this operation shown in drawing 1 within a container 1, etching-reagent L, and the semiconductor wafer W and a container 1 was used, and the same CZ wafer as what was used in the example was used for the semiconductor wafer W.

[0030] And the semiconductor wafer was once taken out from the etching reagent, and after rinsing and drying, it asked for FPD density by differential-interference-microscope observation, and carried out after that by changing the 90 degrees of the directions of a semiconductor wafer centering on the direction of a normal of a semiconductor wafer front face, and repeating operation of **********ing fixed time. Etching was performed 4 times in all and each etching time was set for 5 minutes, for 5 minutes (for

accumulating-totals | 10 minutes), for 10 minutes (for | accumulating-totals | 20 minutes), and as for 10 minutes (for accumulating-totals | 30 minutes). When this is converted into the etching depth, it is equivalent to 3 micrometers, 6 micrometers, 12 micrometers, and 18 micrometers.

[0031] Moreover, it decided to make the defect which has recognized the defect which has recognized the defect which has recognized the defect recognized after the 1st etching after 0-3 micrometers and the 2nd etching as the method of expression of FPD density after 3-6 micrometers and the 3rd etching after 6-12 micrometers and the 4th etching into the defect which appeared in 12-18 micrometers, and to show it.

[0032] Drawing 2 compares the result of the above-mentioned example with the result of the conventional example. The FPD density by the example is decreasing greatly compared with the FPD density of the conventional example, respectively in each etching depth which is 6 micrometers, 12 micrometers, and 18 micrometers so that clearly from drawing 2. In the case of the conventional example, this has many rates with the size of the flow (tracing of the foam from FPD) 200 micrometers or less over the total FPD number of FPD, and is because the part was counted as FPD.

[0033] However, it is proved from the result of drawing 4 mentioned above that FPD with the size of a flow 200 micrometers or less has the large influence by dust adhesion on a wafer front face. Therefore, in the case of this example, compared with the conventional example, the thing with small FPD density was considered because the influence by dust adhesion of a wafer front face is small, and it was proved that FPD density with a high precision was obtained.

[0034] Furthermore, since FPD can only grasp supposing that it generated within the limits of the etching depth corresponding to the divided etching time in the case of the conventional example, as the depth direction density profile of FPD shows drawing 2, it will become a stair-like profile. Then, if etching time is divided more finely, in order for a profile and the opportunity for dust to adhere between etching although it becomes fine to increase, FPD density will become what has a still worse precision. To it, in the case of this example, the depth direction density profile of FPD was able to become smooth curve-like, and has grasped the generating situation of FPD in the more nearly actually near state compared with the conventional example.

[0035] in addition, the technical range of this invention can add various change in the range which is not limited to the gestalt and example of the above-mentioned implementation, and does not deviate from the meaning of this invention For example, in the equipment of the gestalt of this operation, although the vacuum chuck was used as a means to hold a semiconductor wafer, it is possible to replace with this, and to use the carrier which holds a semiconductor wafer mechanically, in addition to add various change about the concrete composition of equipment. Moreover, also in the method of detection of FPD, even if it can set up suitably about conditions, such as rotational speed of a wafer, and etching time, and faces detection of tracing of a foam, you may use arbitrary methods.

[0036]

[Effect of the Invention] As mentioned above, as explained in detail, according to the evaluation method of the semiconductor substrate of this invention By **********ing rotating a semiconductor substrate within 360 degrees with a fixed angular velocity Since etching time, i.e., the etching depth, is found from the direction of tracing of each foam on the front face of a substrate and the distribution of the etching depth direction of crystal-defect density can be detected [only etching once and], Etching time can be divided, it is not necessary to perform washing of a substrate, and dryness for every etching, and the detection work of a crystal defect can be simplified. Moreover, compared with a conventional method, crystal-defect density with a high precision can be obtained because the influence on the defect density measurement by adhesion in the substrate of dust or particle decreases. Moreover, since a semiconductor substrate is rotated continuously and a crystal defect is detected, the depth direction profile of defect density is detectable with sufficient resolution.

[0037] Moreover, the method of detection with the above outstanding advantages of a crystal defect is easily realizable by using the evaluation equipment of the semiconductor substrate of this invention.

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1] It is the method of detecting the density distribution of the etching depth direction of the crystal defect which forms tracing of a foam on the front face of a semiconductor substrate into selective etching. After making it immersed into selective-etching liquid where a semiconductor substrate is stood and rotating this semiconductor substrate for the directions of a normal where this semiconductor substrate is arbitrary within angular velocity and 360 degrees fixed as the axis of rotation. The evaluation method of the semiconductor substrate characterized by discriminating the depth in which a crystal defect exists based on the direction of tracing of this foam by taking out this semiconductor substrate from the aforementioned selective-etching liquid, and observing tracing of the foam formed in the front face of the aforementioned semiconductor substrate.
[Claim 2] The crystal-defect method of detection in the semiconductor substrate which finds the etching time at the time of tracing of the foam being formed from the direction of the value of the aforementioned angular velocity, and tracing of the aforementioned foam, and is characterized by discriminating the depth in which the aforementioned crystal defect exists from the etch rate decided by the kind of the semiconductor substrate to be used and selective-etching liquid, and the etching time found the account of before in the evaluation method of a semiconductor substrate according to claim 1.
[Claim 3] It is equipment used in order to detect the density distribution of the etching depth direction of the crystal defect which forms tracing of a foam on the front face of a semiconductor substrate into selective etching. The container which may make a semiconductor substrate immersed into the liquid while being able to hold selective-etching liquid, A substrate maintenance means to hold where it was installed in this container and the aforementioned semiconductor substrate is stood, Evaluation equipment of the semiconductor substrate characterized by having a substrate rotation means to rotate the aforementioned semiconductor substrate in the state where it was made to hold for the aforementioned substrate maintenance means, and the control means which control the angular velocity at the time of rotation of the semiconductor substrate by this substrate rotation means.

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TECHNICAL FIELD

[The technical field to which invention belongs] This invention relates to improvement of the rack for etching at the wet etching method and its etching-system row of the etching method of a semiconductor wafer, and its equipment, for example, a silicon wafer.

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PRIOR ART

[Description of the Prior Art] Generally, after machining processing of slicing, wrapping, etc. is performed, as for a silicon wafer, etching processing by chemical action is given. This etching process is performed in order to remove the damage produced with machining at the process before the above. Even if it is in the silicon wafer with which it **********ed for next polish etc. simultaneously, regulation fixed at appearance, flat nature, and field granularity etc. is needed.
[0003] Therefore, more various devices than before have been made also about the fixture used for this etching method and etching. Especially the poor field (nonuniformity) according to the reactant gas from a semiconductor wafer front face in connection with the inclination of diameter[of a large quantity]-izing of a semiconductor wafer in recent years has posed a big problem.
[0004] As an etching system of the conventional semiconductor wafer, what was indicated by JP,4-151837,A, for example is known. This equipment allots the presser-foot member of each other which formed in shaft orientations two or more two main rollers which formed in shaft orientations two or more engagement slots which should support a wafer, and same engagement slots free [parallel and rotation] in drum frame-like casing. The rotation drive of the main roller is carried out with a drive. It presses down between the main rollers in casing, and with a main roller, and has prepared in the angular position with a suitable member free [rotation of an auxiliary roller]. An auxiliary roller is driven with a drive.
[0005] Since at least two points of the periphery section of this wafer are supported [if it is in this equipment,] with the main roller and the auxiliary roller even if it is the wafer which has the cage hula OF, and the cage hula OF is in which angular position, the axial center of a wafer does not change but movement of the direction of a path of a wafer is prevented. Consequently, the periphery section does not receive a damage, but the rotation unevenness of a wafer is prevented, and uniform etching is attained.

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EFFECT OF THE INVENTION

[Effect of the Invention] In this invention, the variation in the flatness on each front face of a silicon wafer can be suppressed small. Moreover, the etching nonuniformity within the field on the rear face of front of a silicon wafer can be lost.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] As explained above, in the conventional crystal-defect method of detection, when carrying out the multiple-times receipts and payments of the semiconductor wafer to an etching reagent took out a wafer from eye a required hatchet and an etching reagent, dust and particle adhered to the wafer, and exact measurement was not completed by crystal-defect measurement after etching of the 2nd henceforth. And in order to avoid this, whenever it repeated etching, washing and dryness had to be performed, and it had become the work which requires time and effort and time extremely.
[0013] Moreover, by the conventional method, the depth in which a crystal defect exists can be grasped only as a certain range corresponding to etching time. then -- in order to obtain the etching depth direction profile of FPD density with finer resolution -- etching time -- fine -- dividing -- counting of etching and FPD -- it is necessary to repeat work repeatedly However, if it does in this way, since the opportunity of adhesion, such as dust, will increase increasingly, it is not a desirable method.
[0014] this invention aims at offering the evaluation method of a semiconductor substrate and evaluation equipment which it is made in order to solve the above-mentioned technical problem, and FPD density with a more high precision is obtained by reducing the influence of dust etc., and can obtain the etching depth direction profile of FPD density with high resolution.

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MEANS

[Means for Solving the Problem] In the etching method of the semiconductor wafer which is made to rotate the semiconductor wafer dipped into the etching reagent in invention according to claim 1, and **********s, it is the etching method of the semiconductor wafer to which it is made to move linearly within a perpendicular flat surface to the axis of rotation simultaneously, rotating this semiconductor wafer.
[0010] It is the etching system of the semiconductor wafer equipped with the etching-reagent tub into which the etching reagent was poured, a rotation means to rotate a semiconductor wafer in this etching-reagent tub, and the rocking means to which the rotating semiconductor wafer is moved within a flat surface perpendicular to the axis of rotation in invention according to claim 2.

[0011] It is the etching system of a semiconductor wafer according to claim 2 which has the rack which holds a semiconductor wafer to an abbreviation vertical in the etching-reagent tub into which the etching reagent was poured, and this etching-reagent tub, the driving shaft which rotates a semiconductor wafer in slide contact with the rim of the held semiconductor wafer, and the cam member to which a semiconductor wafer is moved in contact with the rim of this rotating semiconductor wafer in invention according to claim 3.
[0012] while invention according to claim 4 fixes to a driving shaft the piece of maintenance which separates the above-mentioned silicon wafers in the rack which holds two or more silicon wafers and is dipped into an etching reagent by making the rim of a silicon wafer contact two or more driving shafts -- this piece of maintenance -- the surroundings of a driving shaft -- meeting -- projection -- it is the rack for etching formed by the pin-like member of bottom plurality

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EXAMPLE

[Example] Here, the comparative experiments of the crystal-defect method of detection of this invention and a conventional method were conducted. Hereafter, the result is explained. In the method of detection of this example, it supposes that it etches at a room temperature, and an initial oxygen density is 14x1017 atoms/cc (ASTM-121) in the front face (100) of a p type Si wafer as SEKO liquid and a semiconductor wafer as an etching reagent. CZ wafer was used. Moreover, the angle which a semiconductor wafer and an etching-reagent side make becomes 90 degrees (state the semiconductor wafer stood perpendicularly) by using the equipment of drawing 1 .
[0028] Moreover, it computed as a part for R= 0.6 micrometer/of etch rates among the parameters in the above-mentioned (1) formula, and set up for [angular-velocity / of the semiconductor wafer under etching / of omega= 0.15 degrees/second /, and total etching time] 30 minutes. When it etches on this condition, the total angle which a semiconductor wafer rotates will spread 270 degrees and the etching depth, and will be equivalent to 18 micrometers. And the semiconductor wafer after an etching end was rinsed, it dried, tracing of a foam was observed after that using the differential interference microscope, and it asked for FPD density.
[0029] On the other hand, as the conventional method of detection used as the example of comparison, only the vacuum chuck 5 (rotary pump 6) which supports the semiconductor wafer W among the equipment 7 of the gestalt of this operation shown in drawing 1 within a container 1, etching-reagent L, and the semiconductor wafer W and a container 1 was used, and the same CZ wafer as what was used in the example was used for the semiconductor wafer W.
[0030] And the semiconductor wafer was once taken out from the etching reagent, and after rinsing and drying, it asked for FPD density by differential-interference-microscope observation, and carried out after that by changing the 90 degrees of the directions of a semiconductor wafer centering on the direction of a normal of a semiconductor wafer front face, and repeating operation of **********ing fixed time. Etching was performed 4 times in all and each etching time was set for 5 minutes, for 5 minutes (for accumulating-totals] 10 minutes), for 10 minutes (for [accumulating-totals] 20 minutes), and as for 10 minutes (for accumulating-totals] 30 minutes). When this is converted into the etching depth, it is equivalent to 3 micrometers, 6 micrometers, 12 micrometers, and 18 micrometers.
[0031] Moreover, it decided to make the defect which has recognized the defect which has recognized the defect which has recognized the defect recognized after the 1st etching after 0-3 micrometers and the 2nd etching as the method of expression of FPD density after 3-6 micrometers and the 3rd etching after 6-12 micrometers and the 4th etching into the defect which appeared in 12-18 micrometers, and to show it.
[0032] Drawing 2 compares the result of the above-mentioned example with the result of the conventional example. The FPD density by the example is decreasing greatly compared with the FPD density of the conventional example, respectively in each etching depth which is 6 micrometers, 12 micrometers, and 18 micrometers so that clearly from drawing 2 . In the case of the conventional example, this has many rates with the size of the flow (tracing of the foam from FPD) 200 micrometers or less over the total FPD number of FPD, and is because the part was counted as FPD.
[0033] However, it is proved from the result of drawing 4 mentioned above that FPD with the size of a flow 200 micrometers or less has the large influence by dust adhesion on a wafer front face. Therefore, in the case of this example, compared with the conventional example, the thing with small FPD density was considered because the influence by dust adhesion of a wafer front face is small, and it was proved that FPD density with a high precision was obtained.
[0034] Furthermore, since FPD can only grasp supposing that it generated within the limits of the etching depth corresponding to the divided etching time in the case of the conventional example, as the depth direction density profile of FPD shows drawing 2 , it will become a stair-like profile. Then, if etching time is divided more finely, in order for a profile and the opportunity for dust to adhere between etching although it becomes fine to increase, FPD density will become what has a still worse precision. To it, in the case of this example, the depth direction density profile of FPD was able to become smooth curve-like, and has grasped the generating situation of FPD in the more nearly actually near state compared with the conventional example.
[0035] In addition, the technical range of this invention can add various change in the range which is not limited to the gestalt and example of the above-mentioned implementation, and does not deviate from the meaning of this invention For example, in the equipment of the gestalt of this operation, although the vacuum chuck was used as a means to hold a semiconductor wafer, it is possible to replace with this, and to use the carrier which holds a semiconductor wafer mechanically, in addition to add various change about the concrete composition of equipment. Moreover, also in the method of detection of FPD, even if it can set up suitably about conditions, such as rotational speed of a wafer, and etching time, and faces detection of tracing of a foam, you may

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective diagram showing the outline of the etching system concerning one example of this invention.
[Drawing 2] It is the cross section showing the rack of the etching system concerning one example of this invention.
[Drawing 3] It is the side elevation showing the side plate of the rack concerning one example of this invention.
[Drawing 4] It is the front view showing the wafer maintenance state in the rack concerning one example of this invention.
[Drawing 5] It is the side elevation showing the roller shaft configuration concerning one example of this invention.
[Drawing 6] It is the side elevation showing the roller shaft configuration concerning other examples of this invention.
[Drawing 7] It is the side elevation showing the roller shaft configuration of the etching system concerning the example of further others of this invention.
[Drawing 8] It is the graph which shows the etching nonuniformity of the silicon wafer in the etching system concerning the example of this invention.
[Drawing 9] It is the graph which shows TTV of the silicon wafer in the etching system concerning the example of this invention.
[Description of Notations]
11 Etching-Reagent Tub,
12 Rack,
15, 16, 17 Roller shaft (a rotation means, driving shaft),
18 Small Gear (Rotation Means),
19 Inner Gear (Rotation Means, Rocking Means),
21 Outside Gear (Rotation Means, Rocking Means),
24 Belt (Rotation Means, Rocking Means),
25 Motor (Rotation Means, Rocking Means),
30 Piece of Maintenance,
32 Cam Shaft (Rocking Means, Cam Member),
33 Small Gear (Rocking Means),
wf Silicon wafer.

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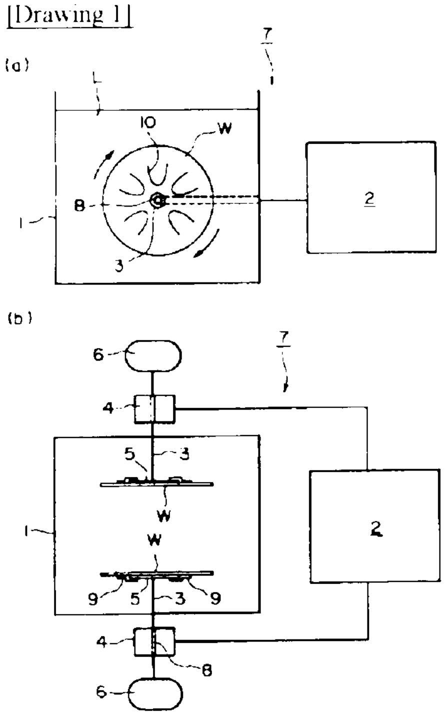
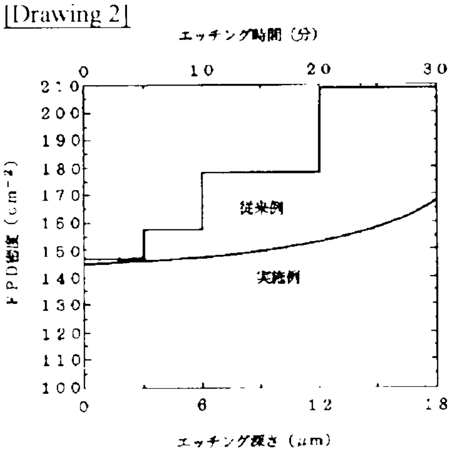
DRAWINGS

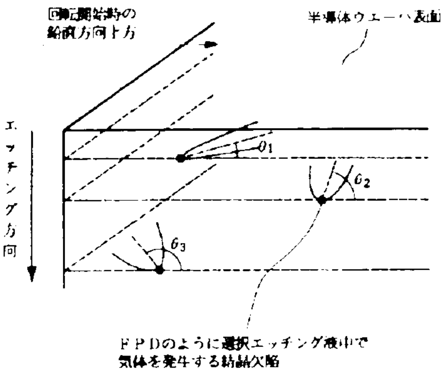
[Drawing 1]



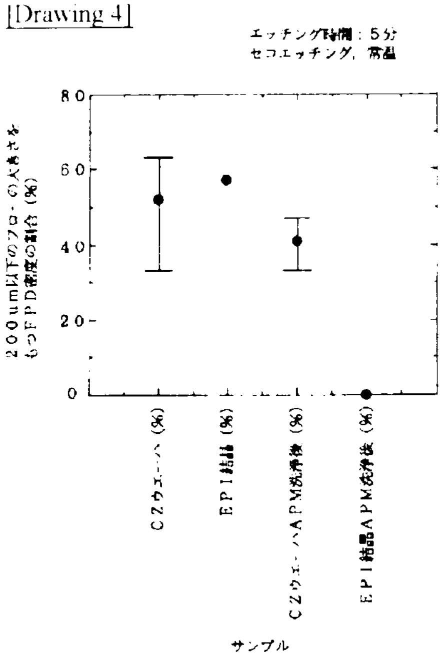
[Drawing 2]



[Drawing 3]



[Drawing 4]



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